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# Copper Exchanged Zeolites for Ammonia Reduction of NO<sub>x</sub> from Biogas Gas Engines

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## 1. What is NO<sub>x</sub>?

- Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO<sub>2</sub>.
- Pollutants, they are involved in many atmospheric processes e.g. formation of photochemical smog and acid rain.
- They are produced as a result of high temperatures during the combustion of fuels.
- Legislation is in place to reduce NO<sub>x</sub> emissions i.e. the European Waste Incineration Directive (WID) regulates activities that involve burning or gasification of waste (Figure 1).

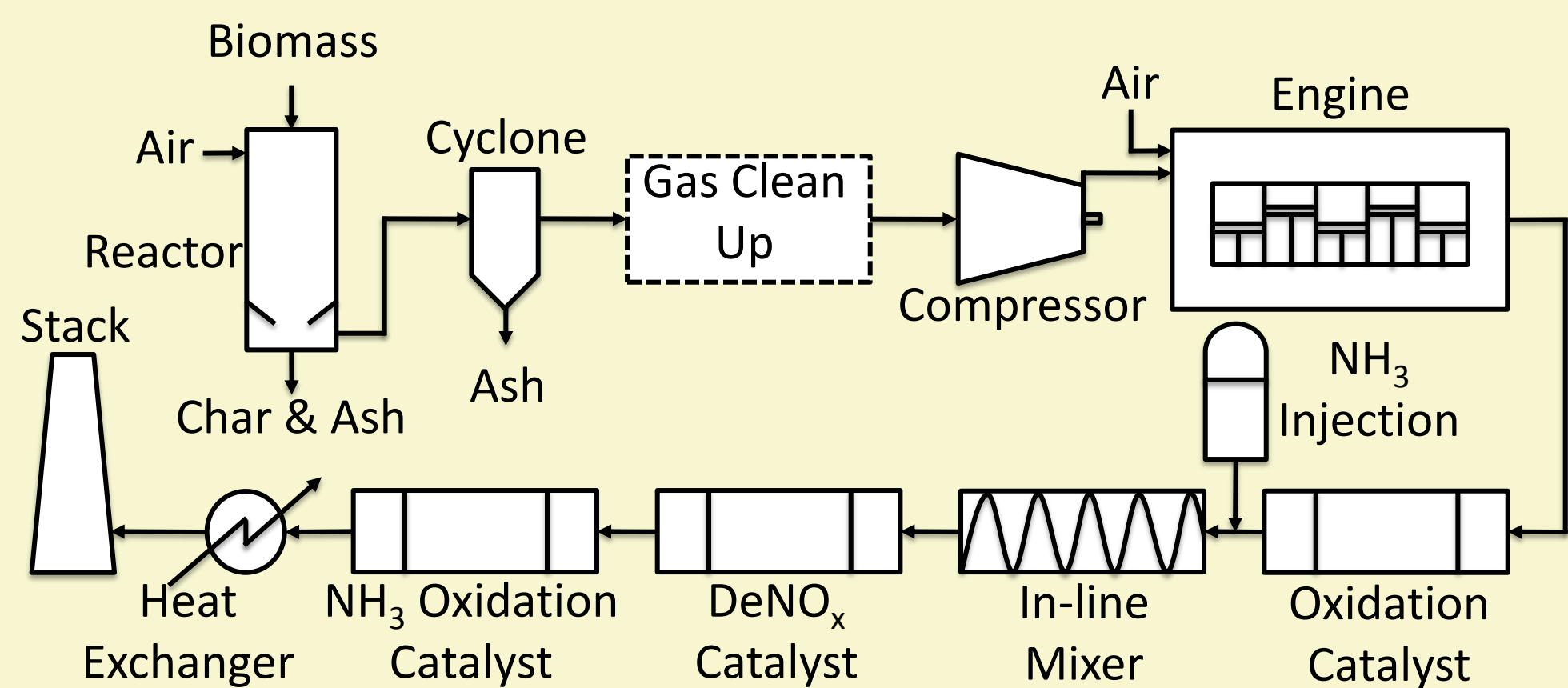


Figure 1. Schematic of proposed biogas engine exhaust treatment system

## 3. Catalyst

- Copper-exchanged zeolites are well known for their NO<sub>x</sub> reduction [2] and direct NO decomposition activity [3].
- Cu-Y and Cu-LZY 82 zeolites were prepared through three-fold ion exchange of the steamed form of LZY-82.

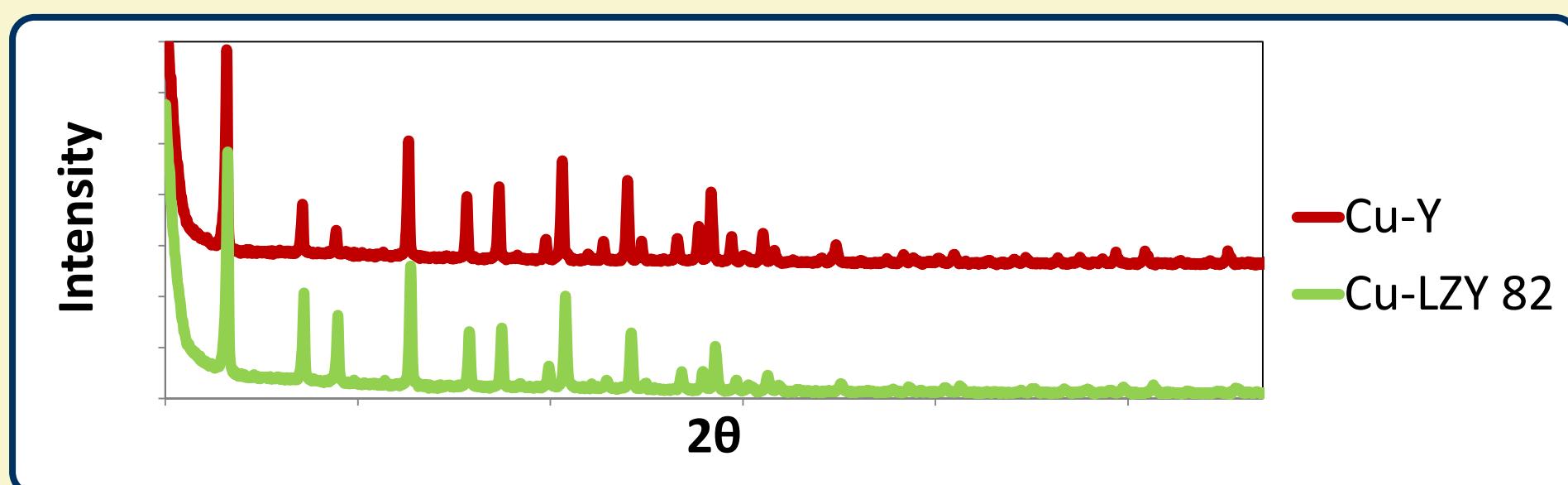


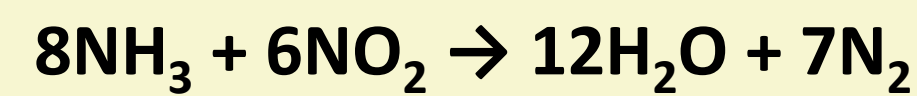
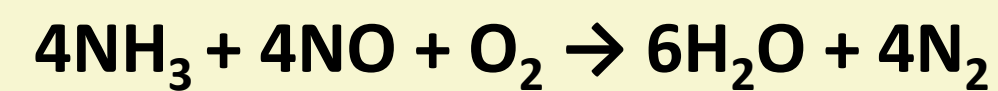
Figure 3. Powder X-ray diffraction patterns of prepared zeolites

## 5. Conclusions

- The copper exchanged zeolites retain the structure of the initial LZY-82 zeolite.
- Both prepared zeolite-Y catalysts demonstrate comparable DeNO<sub>x</sub> activity to the Cu-ZSM 5 standard.
- The production of unwanted side-products is negligible over the measured temperature range.

## 2. DeNO<sub>x</sub> Process

- NH<sub>3</sub>-Selective Catalytic Reduction (SCR) is an efficient, established method for NO<sub>x</sub> removal. The desired reactions are:



- BUT there are some disadvantages including:

- Ammonia slip
- Size of the installation
- Thermal deactivation

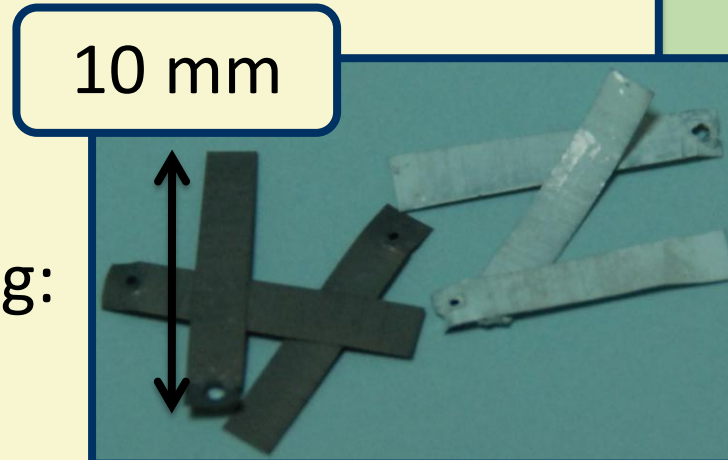


Figure 2. Metal sheet catalyst supports

- Structured reactors based on metallic short channel structures (Figure 2) demonstrate improved mass and heat transfer properties [1] and can remedy these issues.

## 4. Experimental

- Gas composition supplied to catalysts:
  - 2000 ppm NO
  - 2000 ppm NH<sub>3</sub>
  - 3 % O<sub>2</sub>
- Temperature varied from 50-500 °C.
- Prepared zeolites compared to Cu-ZSM 5 standard.

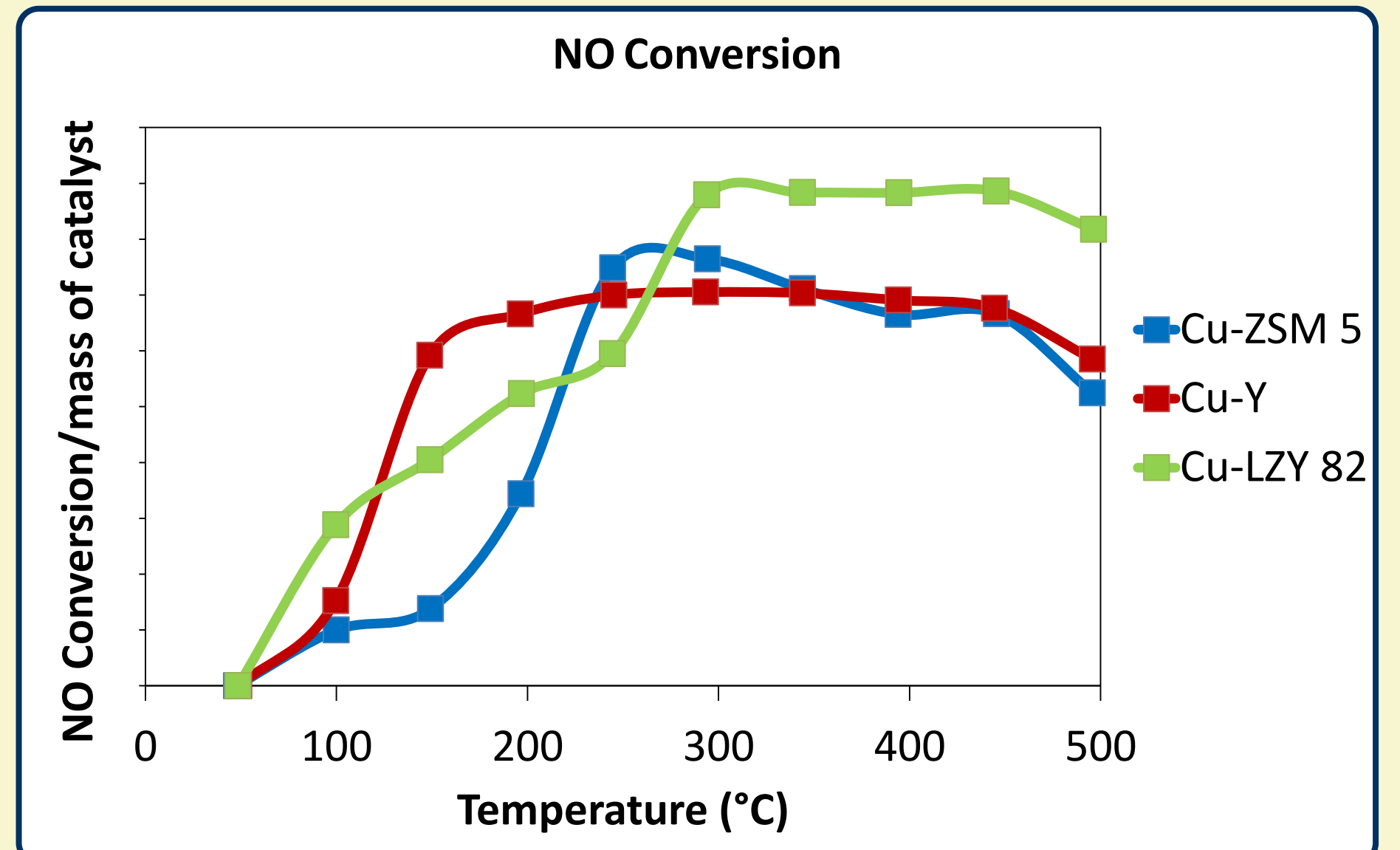


Figure 4. Comparison of NO conversion capabilities of zeolite catalysts

## 6. Future Work

- Prepare zeolite coated metallic sheets.
- Fully characterise both zeolite powders and the supported catalysts through techniques including SEM, Atomic Force Microscopy (AFM) and Raman spectroscopy.
- Repeat catalytic testing to obtain quantitative data for kinetic modelling.

### REFERENCES

<sup>1</sup>Kołodziej, A. & Łojewska, J. 2009. *Catalysis Today*, 147, S120-S124

<sup>2</sup>Sato, S., Yu-U, Y., Yahiro, H., Mizuno, N. & Iwamoto, M. 1991. *Applied Catalysis*, 70, L1-L5.

<sup>3</sup>Iwamoto, M., Yahiro, H., Tanda, K., Mizuno, N., Mine, Y. & Kagawa, S. 1991 *The Journal of Physical Chemistry*, 95, 3727-3730.